

wish for the further clearing of this matter, that observation were made at *Bristol* (because there is the most considerable Flux and Reflux of any Port of England,) Whether this year 1670. the Tydes be not higher (*consideratis*, &c.) when the ☿ passeth ♋. ♎. and ♏, than when she passeth through the opposite signs ♊. ♍. and ♌; and particularly whether the Spring Tydes be not sensibly higher after the *Change*, than after the *Full* in *February*, *March*, and *April*; and higher after the *Full* then after the *Change* in *August*, *September*, and *October*; and also, Whether the Neap-tides in *May* and *June* rise not apparently higher than expected. I am promised, the observation shall be made here at *Weymouth* for this whole year round; from whence I have already received this account, that this present *February* 1670. the Spring-Tydes ran very high after the *Change*, though the weather were pretty calm, and that wind that was not very favourable to the Tydes, and that the Spring-Tydes after the *Full* were very low, and weak, which is exactly according to my conjecture.

Dr. Wallis's Answer to the foregoing Animadversions, directed in a Letter to the Publisher, March 19. 1670.

SIR, Yours with the inclosed Animadversions of M. *Childrey* on my Hypothesis of *Tydes*, came so late to hand on Thursday last (when the Post was almost ready to be gone) that I had not time, by that Post, to give you an account of them. And it is not much, I need to say now; for I do not find, that he and I are like much to disagree.

That the *Winds* have a great influence on the Tydes of particular Coasts and Havens, according as they are more or less stiff or slack, and blow from this or that part, I do not at all question; but did alwayes take for granted, as generally received, and upon good grounds. And the like I say of *Land waters*; which (though as to the Sea they signify not much in this point) are, as to In-land Rivers, very considerable; especially as to Inundations upon rising of the Water: Which is rather by Checking than Promoting the Tydes. For certainly, these Land-waters, meeting the Tyde of Flood, do hinder it from coming so far up the River as otherwise it would; and consequently, if, notwithstanding such Land-floods,

floods, the Tyde flow higher up the River than at other times, this must be derived from some other cause. But, that the Tide and Land-flood should joyntly make a greater Inundation than either singly would have done, is not to be doubted. But he need not wonder, that in my *Essay*, though I grant both these, I said so little of either, because it was wholly beside my business; which was, to give a *Statical* account of *Stated Periods* (*Diurnal, Menstrual, Annual,*) arising from Regular Motions; not, of *Accidental Extravagances*, such as these are: And therefore I did, in the beginning of that Discourse preclude the Consideration of the Advantage or Disadvantage, which should arise from such uncertain Contingences, as Extrinsecal to that business.

His *third* thing suggested, The *Moon's Perigæsis*; is so far from being contrary to my *Hypothesis*, that it is a great Part of it. And (if I do not much mis-remember,) it is, in one of my Letters to you, expressly mentioned as such. But forasmuch as it doth not still fall out at the same time of the Day, Month, or Year, I could not make it a Component of any of those noted Periods, Diurnal, Menstrual or Annual; (and of more Periods than these, I did not know that there hath been any general notice taken, of which I might think my self obliged to give an account:) but it may very well influence *any* or *all* of those, according as it falls out advantageous or disadvantageous for them.

And as I do so readily concur with him in all the particulars by him suggested; so I think he will not be difficult in assenting to all the Materials of my *Hypothesis*.

The account which I give of the *Diurnal* and *Menstrual* Periods (from the *Common Center* of Gravity of the Earth and Moon,) he doth allow as very Rational: And consequently (which is the Foundation of it,) that any Acceleration or Retardation of the Compound motion of the particular parts in the Earth's Surface, is to give such an Accumulation of waters as causeth a Tyde; and the Complication of such Accelerations and Retardations, concurring or interfering one with another, doth occasion the perplex Varieties in them: Of which therefore there is no clear account to be given, without considering severally the proper Effects of each, from whence doth result the Compound Effect of all together.

Now as to the two most signal motions of the Earth, the *Diur-*

nal and *Annual* ; if we suppose them each in themselves Equal, and both perfectly circular and upon Parallell *Axes*, though neither of them, singly consider'd, would give an Inequality of motion ; yet the compound of both together, being swiftest at Mid-night and slowest at Noon, (because the compound of both is, in *that*, the Aggregate, in *this*, the difference of them) would give us two Tydes in each *Diurnal* Revolution : But those alwayes at Noon, and Mid-night.

If to these we add the *Menstrual*, whereby the Earth describes a small *Epicycle* about the Common Center of Gravity of the Earth and Moon ; and suppose this also Equal in it self, and Circular, about an *Axe* parallell to the rest : neither would this, of it self, give any Inequality ; but, compounded with the rest, it will. For, *this* compounded with the *Annual*, doth, at the New Moon, *increase* ; at the Full, *abate* of that motion, as to all parts of the Earth's Surface : But compounded with the *Diurnal* (which, in this case, is much the more considerable, as recurring every day,) it doth most *add* to, or *abate* of, that motion, as to each particular place of the Earth's Surface, when the Moon is in the Meridian of that place, *below* or *above* the Horizon ; and would therefore, at those times, give us two Tydes. (For which, and other particulars of like nature, that they may be the better apprehended, I refer my self to the Inspection of the *Schemes* pertaining to my *Hypothesis*.)

Now because this coming of the Moon to the *Meridian*, above and below the Horizon, or (as Sea men call it) the Moon's *Southing* and *Northing*, doth, in a Month's time, pass round the whole circle of 24 hours ; hence it comes to pass, that the time of the Tydes doth so also : Which I take to be the true Account of the *Menstrual* period. And because this Composition of the *Menstrual* with the *Diurnal* (which seems by the Effect to be most predominant, though not to extinguish the other,) casts the time at the Moon's being in the *Meridian* ; and that of the *Annual* and *Diurnal*, when the *Sun* is in the *Meridian* : When both these happen at the same time, as at the Full and Change of the Moon ; the Tydes must needs be the greater : Which I take to be the true Account of the *spring-Tydes*, and *Neap-Tydes*. And thus far (which is the main of my *Hypothesis*,) he concurs with me, as having given at least a very Rational and Probable Account.

If therefore there be no other Periods of Tydes but these ; or no other remarkable, my work is done, and I need not be further solicitous : For, then there will seem to be either no other inequality of motions, or none considerable. But, if there be also observable an *Annual* period, (as very many think there is ;) or any other such period, (as perhaps there may be,) then are we to seek for the Cause thereof in somewhat of Inequality, which doth (for the *Annual* Period) *Annually* recur ; or (for any other Period,) which doth recur in such a time as that other Period doth require.

Now forasmuch as the three Motions above mentioned are neither (as was above supposed) each Equal in it self, or perfectly Circular, nor all on Parallel *Axes* ; there is, both as to the Sun, and as to the Moon, at least a double Inequality ; the *one*, by reason of the *Excentricity*, and (which depends thereon) the *Apogæum* and *Perigæum* ; the *other*, by reason of the *Obliquity* of the *Zodiack* and the Moon's *Orbite*, with the *Æquinoctial*, and with each other. From every of which doth proceed some little Inequality of Motion in the Earth's Surface : But whether so much as to make any remarkable alteration in the Tydes, is hardly determinable than by observation.

Now for that of the *Moon*, both as to its *Apogæum* and *Perigæum*, (with the Inequality of Motion depending on it ;) and as to the *Obliquity* of its *Orbe* both with the *Zodiack* and the *Æquator* (which causeth another Inequality both in the Motion of *Longitude* and *Right Ascension*,) I have hitherto contented my self to insinuate it, in one of my Letters on this subject, without further insisting on it ; because I did not know of any Periodical Vicissitude of Tydes consonant thereunto. When any such shall be discovered, we have here a Foundation ready for the Salving of it. But as to any *Annual* Vicissitude, it is not of use, because it doth not *Annually* recur. See page 2033 (1666).

But, because it hath been almost generally received, That there is an Observable *Annual* Period ; I did, for the salving of that, apply not the *Inequality of the Natural Dayes*, but those causes from whence *that* proceeds, the *Excentricity* of the Sun or Earth's *Orb*, and the *Obliquity* of the *Zodiack*. The *former* of these, if singly considered, would cast those Annual Tydes in *June* and *December* (the times of the Sun's *Apogæum* and *Perigæum*, or rather the Earth's *Aphelium*.)

Aphelium and *Perielium*, when are the slowest and the swiftest Annual motions in the Zodiac :) the *latter*, if considered alone, would cast them upon the two *Æquinoxes*, and the two *Solstices*, (the times of the Least and of the Greatest *Right Ascensions*;) But if both be jointly considered, they must cast these (as they do the greatest Inequality of the Natural days) at some intermediate times, between the *Autumnal Æquinox* in *September*, and the *Perigæum* in *December*; and again, between this *Perigæum*, and the following *Vernal Æquinox* in *March*: As is more than probable (without the trouble of any new computation) from the greatest Inequality of the Natural Days, arising from the same causes: But whether precisely at the same time with that Inequality, or whether in all parts of the world at any one time, I do not undertake there to determine; but rather believe the contrary, because the different Position of places may very much alter the Influence of both or either Causes. I did only mention, as a thing very notorious, that it doth so constantly fall out on the coasts of *Kent*; and particularly of *Rumney-marsh*, about *Allhallontide* and *Candlemas*.

This Account of the *Annual* Vicissitude is that only, to which *M. Childrey* doth except; opposing *first*, the Judgement of Seamen (more considerable than that of the Inhabitants of *Rumney-Marsh*;) who use to say, either that the time of the year signifies nothing; or, if at all, it is about the *Æquinoxes*. Then, that if this be the cause, it will be constant, and *that* in *February* as well as in *November*. And thirdly, that the Seamen about *Weymouth* have not observed any thing signal about those Times.

To the *first*, I answer; if not then, but at the *Æquinoxes*, then so much of the Hypothesis as concerns the *Excentricity* may be spared, (or allowed to be so little as not to be remarkable;) and that of the *Obliquity* alone will give a sufficient account of it. Or if (to which he seems rather to incline,) there be no such *Annual* Vicissitudes at all; then may that of the *Obliquity* be spared also, and the *Hypothesis* perfect without it. And, till some such be observed and acknowledged, it will be sufficient to say, That, though both the *Excentricity* and *Obliquity* do cause some Inequality in the Motion; yet so little, as that in the Tydes it is not remarkable, they falling just as if the three Motions, (Annual, Menstrual, Diurnal,) were all exactly Circular, and on Parallel *Axes*.

To the *second*, which concerns matter of Fact in *Rumney-Marsh*; I say, that (according to the best account I can there get, and the unanimous consent as well of Fisher-men and other Water-men, as of other Inhabitants,) it is constant; hardly missing (or very seldom) any one year (be the weather fair or foul;) and as well about *Candlemas*, as about *Allhallontide*, every year, though not then so high: Of which (though they do not pretend to give any reason of it,) I think a Cause may be very rationally assigned. For, if you consult the *Tables* of the *Inequality* of *Natural Days* (which parallel I make use of for the Explication of this,) you will find, that about one of the Extrems (in *January*) the Increase and Decrease of the Natural Days fluctuates very much; sometime increasing, sometime decreasing, according as this or that of the two Causes, thwarting one another, doth prevail: But about the other Extream (in *October*,) it is much otherwise; the *Increasing*s and *Decreasing*s going on in a continual course for a long time together. And the same Causes, applyed to the business of Tydes, may very rationally be supposed to produce as unequal effects.

To the *third*, That the Sea-men at *Weymouth* have not observed any such signal Effects about *Allhallontide* and *Candlemas*: It is very possible that they have not, and that nothing signal on those Coasts useth to happen at those times: For, I fix that matter of Fact principally on *Rumney-Marsh*, (and that it doth there constantly happen, I am pretty well out of doubt,) and do but by conjecture extend it to the River of *Thames* (as having its Mouth not far from those Coasts,) where yet, I think, you can be my Witness, that it hath been observed several years to succeed accordingly. What variety is on other Coasts, I am not certain: But (from an Account read in the *R. Society* in my hearing, about the end of the year 1667.) I understand that about *Chepstow-bridge* (and consonantly, I suppose, on the *Severne* at other places,) they observe the like to happen about the beginning of *March*, and end of *September*, (the one as much *before* the *Vernal*, as the other is *after* the *Autumnal* *Æquinox*, like as in our case it happens,) which they call by the name of *St. Davids stream*, and *Michaelmas-stream*; as we do those in Kent, *Candlemas stream*, and *Allhallon-stream*: (And when Sea-men take so much notice of particular Tydes as to give names to them, 'tis a great presumption, that it is for some remarkable

kable Accident usually happening at those Seasons.) Of these different Seasons at *Chepstow bridge* from those of *Rumney-Marsh*, I gave you my remarks in a Letter of mine to you in *March* following. And the like differences, I suppose, will be observable on other Coasts, according as their positions be advantageous or disadvantageous to the one or the other of the two Causes, on which this *Phænomenon* depends. But since it is not yet (it seems) agreed, Whether such an *Annual* Phænomenon do happen; or, if so, not at that time; (so that, for ought yet appears, it may be at the Seasons I design, that is, between the Winter-Solstice and the two *Æquinoxes* on either side of it; though, on several Coasts, severally remote,) I think it best to let this part of the *Hypothesis* stand as it is, unrevoked, as that, which, when it shall be discovered and agreed on, stands ready enough to give a rational account of it, and, in the mean time, does no hurt. And in such a Complication of Causes so abstruse, scarce any thing but Observation will determine, which of the Causes, and in what degree, is to be Judged prædominant.

And if to this of the *Sun's* or *Earth's*, be added that of the *Obliquity* and *Excentricity* of the *Moon's* *Orbite* (of which, for the reason above-mentioned, I had taken so little notice,) it will, if it do no good, at least do no hurt. And I the rather think, it may be considerable, because the Earth and Moon's Appropinquation and Elongation, doth really alter the Distance of the *Common Center of Gravity* (of the Earth and moon) from the Earth (rendring the Earth's *Epicyle* Elliptical;) and much favors what *M. Childrey* observes of the Moon in *Perigæo*. And this is the sum of what I thought proper to return you, upon those Animadversions, being, &c.

An Accompt of some Books.

- I. DISSERTATIONES MEDICÆ TRES: 1. De *Causis fluxûs Menstrui Mulierum*. 2. De *Sympathia variarum Corporis partium cum Utero*. 3. De *Usu Lactis ad tabidos restituendos, & de immediato Corporis Alimento*. Auth. Francisco Bayle, Doct. Medico. Tolosæ, 1670. in 4°.

THIS Ingenious Author to prepare his Reader to a candid reception of these Discourses, represents in the Preface, how much mischief and prejudice hath been done to knowledge both
by